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Farmers' risk rating and crop portfolio choice in Kewot Woreda, North Ethiopia

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Production risk and marketing risks are considered as critical factors in shaping farm decisions. This study is concerned with assessing crop risk rating by farmers and its impact on their crop portfolio choice. 392 farmers who were selected using "Multi-stage Random Sampling" technique and qualitative data from focus group discussions were employed in the analysis. The risk rating was done using a three-stage rank and Ordinary Least Square econometric regression was applied to identify the determinant factors. The study found sorghum, teff, onion and mung bean as major crops covering 95% of the total cultivated land. Results from descriptive statistics revealed that 73% of the respondents prioritize marketing over consumption in their crop choice decisions. Mung bean was identified as a riskier crop while onion risk rating showed higher variation among respondents. Findings on determinants of riskiness of the farmers' crop portfolio choice showed that livestock ownership, education and number of crop types found positively associated with riskier crop portfolio while irrigation use and gender of the household head associate with portfolio riskiness negatively. The major contribution of this study is its explicit treatment of farmers own risk rating and farmers also rated crops not grown by them. The key policy implication is that to manage marketing issue better and achieve optimal crop choice, there is a need to develop marketing insurance and promote pre-contract for riskier crops.

Keywords: Risk variation, consumption decision, contract, farm household, insurance.

INTRODUCTION

Climate change is becoming key issue with agriculture and food security as there is a wider concern among researchers that weather variability has negative impact on the performance of agriculture (Rosenzweig & Parry, 1994; Peker *et al.,* 2019). This is particularly true in low-income countries like Ethiopia, where agriculture is mostly rainfed and institutional capacities are low. In the dry land parts of the country where crop yields are principally limited by high rainfall variability, it could affect millions (Hope & Lingard, 1992). The degree of attention to the behavior of agricultural producers under risk has recently been increased by the progressive liberalization of the world agricultural markets (Deressa *et al.,* 2008). Since Climate change is likely to increase vulnerabilities and hazards, risk management will be the focus of the future agriculture.

Since agriculture is a key sector in Ethiopia, its effective transformation is essential for meeting the country's domestic food requirements and to increase its performance in the economy. Commercialization of the sector is important to link smallholder farmers to markets and create opportunities for off farm activities. Generally, the level of commercialization in Africa is very low as only 10% of the crop farmland is used for cash crops and only 30% of the small-scale farmers sell staple grains in Eastern and Southern Africa (AGRA, 2014), which in itself is not sufficient to lead to improved food security. Promotion of production and utilization of crops that matures fast and require small amount of moisture such as mung bean is identified as innovative strategy for enhancing adaptation in crop production in drought-prone lowland areas of the country (Bewket *et al.,* 2015). Pervasive economic and social risks are facets of life for rural households in low-income developing countries (Mogues, 2016). All management decisions are subjected to risk where price, yield and resource uncertainties are major parts of agricultural activities and systems. Fafchamps (1992) demonstrated that farmers' crop choices are hugely dependent on price and yield risk. Farm production decisions, such as crop choice, remain part of risk management strategies (Just & Candler, 1985). Existing studies analyzing risks of smallholder production sees generally crop diversification as risk minimizing action

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(e.g., Dorward *et al.*, 2005; Deressa *et al.*, 2008) and use crop riskiness index from panel data to analyze risk (Bezabih & Di Falco, 2012). But according to Pedersen (2013) the risk perceived and subjectively assigned by the decision maker is important in analyzing decisions. Unfortunately, not much research has been conducted to determine farmers own risk rating and its link with choice. The aim of this study is to increase production efficiency through efficient management of risk and its influence on crop choice decisions.

MATERIALS AND METHODS

Description of the study area: The study is done in Amhara regional state, North Shewa zone of Ethiopia. It has a predominantly *kola* [2] agro-ecology. Ethiopian economy is dominantly run by agriculture and service sectors engaging 98% of the labor force (CSA, 2017). The livelihood is mainly dependent on crop production mixed with livestock rearing. The land is depleted, and productivity is low as a result, making agricultural growth rate slower. There are two rain-fed harvesting seasons named *meher*[3] and *belg*[4], with more harvest from *meher* utilizing *kremt* rains. Sorghum, maize, teff, mung bean (*masho*), onion, tobacco, fruits and vegetables are the main crops produced. Oxen are a source of power for the cultivation of agricultural lands in addition to human labor. Livestock are also source of supplementary income through milk, butter, meat, and egg production.

***Population, sample size and sampling techniques*:** The study was carried out in kewot *woreda* of North Shoa Zone with total population of 118,381 (CSA, 2017). Using a multi-stage Random sampling technique, 400 households were selected from 5 kebeles[5]. Kewot woreda was purposively picked, considering the potential growing area of the target crop (mung bean). Second, 5 *kebelles* were randomly selected from the woreda. Finally, 400 farm households were selected using proportionate random sampling where 8 of them were dropped due to technical issues. The required sample size was computed using equation 1 which is developed by Yamane (1967). The data were collected in the 2017/2018 season through trained enumerators using a pre-tested questionnaire.

$$n = \frac{N}{1+Ne^2} \quad (1)$$

Where, n = sample size; e = error limit; N = Total household number

***The variables and estimation technique*:** The first objective is estimation of crop riskiness based on farmer's rating using a three-scale rating for three components of risk that are production, output price and input price. Crop specific riskiness is estimated using Sum-score (Bauer & Curran, 2016) which is given in (2).

[(Price riskiness + production riskiness + input riskiness)/3] (2)

Crop portfolio riskiness at a household level is by using the riskiness measures of each crop multiplied by the land allotted to each. To this end, the single index measure developed by (Bauer & Curran, 2016), where riskiness of the crop portfolio is estimated from crops riskiness index computed multiplied by land allotted for each crop using (3).

$$[\sum_{i=1}^{i=n} Ri * Li] \quad (3)$$

Table 1. Sample distribution.

Districts	Abay atir	Yelin	Tere	Kure Biret	Shoarobit	Total
Population	8,112	6,855	9,415	5,455	5,873	35,710
Sample households	91	77	105	61	66	400

Table 2. List of independent variables with their definition and measurement

List	Variable name	Operational definition and measurement
X1	Distance to market	Distance from nearby market in km
X2	Gross animal	Number of sheep and goats
X3	Irrigation	Irrigation use 1- irrigation used 0- No irrigation applied
X4	Livestock ownership	Total number of livestocks
X5	Sex of the household head	Sex of the household head 1- male headed 0- female headed
X6	Cultivated land size	Total land cultivated in Ha
X7	Education	Education Level achieved by the household head 1= elementary and above 0- read and write
X8	Marital status	Marriage profile 1- married 0- single (single, divorced and widow)
X9	Land type	Land profile 1- high fertility 0-poor fertility
X10	Farm location	Characteristics of land plot 1- single position 0- multiple plots

[2] Kola- an area with a higher temperature

[3] Kiremt/Meher- long rain season in Ethiopia - June, July, & August

[4] Belg (Autumn) – short season in Ethiopia - March, April, & May

[5] Kebele- smallest unit of Government administration

Using crop portfolio riskiness as a dependent variable Ordinary Least Square regression model is used to identify factors affecting crop portfolio riskiness. Ordinary Least Square (OLS) is an econometric model used to identify direction and coefficient values for relationships between dependent and independent variables. OLS is chosen because the dependent variable is continuous. The functional form of the OLS model is given as follows:

$$Y = \beta 0 + \sum \beta_i X_i + \mathcal{E} \qquad (4)$$

Where Y is the dependent variable, β_i represent coefficient values, X_i stands for explanatory or independent variables (Table 2), and Ɛ is random error.

***Descriptive statistics*:** Data characterizing the surveyed households is given in table 3. The average age of the respondents was 41 years, with a minimum of 20 and a maximum of 68 years. The result depicts that the farm households were in active working age and were relatively younger, tending to adopt new crops, take a risk and have the ambition for higher income and commercialization (Thomas *et al.*, 2017; Milkias & Abdulahi, 2018). Family size ranged from 2 to 9 people with average family size of 4.14 members, which is slightly lower than regional average of 4.3 (CSA, 2017). The increasing family size especially in rural areas causes the land holding of each household to decrease influencing crop choice (Worku, 2018).

Table 3. Summary Statistics of the Respondents

Variable Mean	Category	Frequency	Percentage
Educational Status	Illiterate	80	20.41
	Read and write	288	73.47
	High school completed	24	6.12
Marital Status	Single	24	6.12
	Married	360	91.84
	Divorced or widow	3	2.04
Gender of the household head	Male	351	89.54
	Female	41	10.40
Age of the household head (mean)		41.0	
Family size (mean)		4.14	

***Drivers of farmers' crop choice*:** Although risk, land features and socio-economic factors influence farm decision made by the household, additional factors like households' concern of family consumption, market associated problems, and institutional variables are recommended to be considered in investigating what influences farm decisions (Hunadanol, 2013). In this regard this study addresses the three issues separately.

The results in table 4 showed that 73% of the respondents choose marketing as their primary objective in crop choice decisions. Even though consumption ranked second behind markets as a driver for smallholder farmers' choice of crop production the difference is higher implying that farmers in the study area are more commercialized. The low figure to government and NGO interference shows that in the study area decisions are done exclusively by the household and less dependence on institutions.

Table 4. Priority in farmers' choice of crops for production

Reason	Primary choice
Marketing	73%
Consumption	24%
Past experience	2%
Government and NGO interference	1%
-Market access to crops for consumption	Easy 85% Difficult 15%
-Crop market price rating	0% Cheap 75% Medium 25 Expensive

One of the most complex issues in crop choice decision is whether production and consumption decisions of agricultural households are separable or not. In addition to the difference between marketing and consumption shown in table 4, this study attempts to check independence of production and consumption decisions using indicators. Thus, the separability could be shown as 85% of the respondents say they can easily get the crop they want for consumption including crops not produced in the area (see table 4) and 75% of the respondents judged market crop prices as medium, this is supported by focus group discussion participants also. The findings are in line with the result of Negassa & Jabbar (2008) where no link was found between household's taste for different crops and household land allocation across crops associated with higher market integration. This shows consumption decision and agricultural production decisions must only be linked through profit effects.

***Crops and their primary purpose*:** Households make a choice on what crop to grow among crops that could grow with in the climatic and land features. In the making of these choices farmers usually characterize crop with certain objective which is in their mind ahead of the crop season, which is either for home consumption or marketing. In this study farmers were asked their primary motivation for growing the major crops in the area which is presented in Table 5.

Table 5. Summary of farmers reasons of crop choice.

Reason	Rank	Crops associated
Family consumption	1	Sorghum
Cash income	2	Sorghum, onion, Teff, Mung bean
Past experience/ tradition	3	Sorghum, onion
Intervention (Government or NGO)	4	Mung bean

In this study, sorghum is found as a crop preferred primarily for home consumption and associated also with past experience as it is considered as cultural crop where 92 percent of the respondents produced it. Cash income all major crops are part of cash income despite their difference in their

allocation to market and consumption. Mung bean is the only crop associated with intervention as it is a newly introduced crop and contributing to foreign exchange extension workers are advising farmers to grow it.

Crop choice changes with time is captured as 80% of the farmers said they switched in the past due to productivity and marketing reasons or expect to switch in the future looking on productivity and market.

***Measuring riskiness*:** A farmer's choice of risk management strategies is of vital importance for the viability and continuation of the farm business. Reducing the risk portfolio is among the commercialization strategies ultimately affecting crop choice. Under this to capture farmers' risk attitudes first riskiness score is estimated (table 7) from their own rating and examined how their crop portfolio look like in terms of riskiness. Empirically, how farmers decide under risky conditions is best analyzed by taking into account their risk perceptions and risk attitudes or preferences. For commercialization to be effective crop choices should not depend on the risk attitudes and consumption preferences.

Important risks associated with each major crops produced in the study area are presented on table 6 along with their risk management strategies. For mung bean its perishability is the most important risk and farmers make pre contract directly with exporters as a strategy. For onion still the major risk is marketing problem but the way they address is different as unlike mung bean, onion is supplied for local market, farmers use own or family vehicles to directly collect production and take to markets with less or no involvement of whole sellers and brokers. While the risk associated with teff is production risk which is linked with disease.

Table 6. Major risks by crop type.

Variable Crop type	Most important risk	Risk management strategies
Mung bean	perishability	Pre contract
Onion	market	Market linkage
Teff	disease	Chemicals

Risk analysis encompasses the assessment, management, and communication of risk as well as how risks are perceived and compared (Birthal & Hazrana, 2019). One of the objectives of this paper is to generate riskiness measures of the selected crops and Table 7 provides riskiness score of the 4 crops grown in the study area. Based on respondents rating mung bean and onion are found to be the riskier crops and looking on the standard deviation onion has 0.75 showing that farmers have more diversified opinion on rating riskiness of each crop, while looking on the deviation on risk types farmers have relatively wide opinion on price risk than production and input price risk. Similar results were reported by (Mintewab & Mare, 2012) where they found considerable variation in riskiness and returns across crops.

Table 7. Riskiness scores by crop type.

Crop type	Riskiness score	Standard deviation
Mung bean	6.80	5.83
Teff	4.66	4.61
Sorghum	3.90	3.57
Onion	6.20	7.14

***Crop portfolio riskiness and its determinants*:** Ordinary least square model used to identify the factors that influence riskiness of crop portfolio. The model was tested for multicollinearity using variance inflation factor (VIF) as well as correlation coefficient among explanatory variables was detected, where both tests confirmed no multicollinearity problem in the regression. Furthermore, maximum likelihood parameter estimation indicated (R^2) value of 47 percent and statistically significant.

The model result (Table 8) indicates that irrigation use, livestock ownership, education, marital status, and number of crop types grown were found to be determining farmers risk behavior.

Table 8. Regression result.

Variable	Coefficient	Standard error	z	P>|z|
Distance to market	0.0013	0.00087	1.53	0.125
Gross animal	-0.0774	0.07290	-1.06	0.288
Irrigation	-4.8134*	1.87802	-2.56	0.010
Livestock ownership	22.5910***	2.27534	9.93	0.000
Sex of the household head	-0.4457	2.50561	-0.18	0.859
Cultivated land size	-1.1340	0.86771	-1.31	0.191
Education	4.8981***	1.87719	2.61	0.009
Marital status	-7.6284***	2.69464	-2.83	0.005
Land type	0.6123	1.14866	0.53	0.594
Farm location	1.7325	2.39457	0.72	0.469
Number of obs.	= 392			
F(12, 379)	= 30.22			
Prob > F	= 0.0000			
R-squared	= 0.4890			
Adj R-squared	= 0.4728			

(Note: *, **, and *** represents statistical significance at the 10, 5 and 1 percent level, respectively.)

Irrigation is significant at 95% and having negative effect on portfolio riskiness indicating high price risk than production risk in the study area. Similar results are found by (Sebastien & Erdlenbruch, 2012) where irrigation is found as one of risk mitigating strategies and irrigation users found with less risk portfolio. Such result is significantly and positively related to the need to urgently address price risks.

Livestock ownership is used as an indicator of wealth allowing them to invest in new technologies and take risk. The result indicates that households owning more livestock

involve in production of more risky crops. Literatures (Negassa & Jabbar,2008; Luh, 2017) also suggested that cattle are major means of wealth accumulation in rural areas and one of the risk mitigating strategies.

There is a positive relationship between educational level and portfolio riskiness 5% significance levels. The results suggest that as the educational level of household prefers riskier crops, and this could be down to risk management and information accessed and analyzed by the educated farmers. This result is parallel to the findings by (UNESCO, 2017; Christine *et al.*,1998) who confirmed the positive and significant impact of farmers' education on farmers' decision of choosing diversified crops such as cereals in combination with high-value crops, for example, cash crops and vegetables under irrigation agriculture.

With regard to the parameter of marital status, it is statistically significant and has positive relationship with portfolio riskiness. The results indicate that married household heads prefer less risky crops in their crop portfolio choice. This may be explained by the focus of married household heads on less risky crop targeting family consumption. The finding is consistent with (Mottaleb & Rahut, 2018) who found that married households are risk-averse and not willing to take risks.

With reference to number of crop types grown, results reveal a positive association with portfolio riskiness. This result implies that farmers try to grow riskier crops by increasing the number of crops grown which helped them diversify their choice. Literature complements the result as (Coelli & Fleming,2004) identified diversification as one of risk mitigating strategies.

***Conclusion*:** Crop revenue and own consumption need found as main drivers of crop choice where consumption objectives forced farmers to make decisions against higher value crops. Crop perishability in storage and price fluctuations are found as major crop production risks in the study area, significant variation in risk rating across households is found while based on respondents rating mung bean and onion are found as more risky than teff and sorghum.

The study obtained irrigation use, livestock ownership, education, and marital status significantly influencing riskiness of crop portfolio choice. Irrigation users, illiterate farmers and women headed households are found with less risky crop portfolio. Policymakers should prioritize addressing price risk related issues in the form of loan and insurance.

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